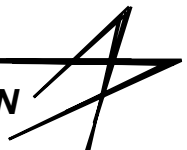


Alpha Magnetic Spectrometer - 02  
(AMS-02)  
Critical Design Review

Operations Overview

Prepared By: P. Nemeth



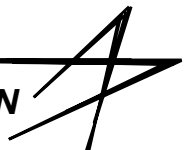
# Contents

- Prelaunch
- Ascent
- Mission Abort
- On-Orbit
  - Space Transportation System (STS)
  - International Space Station (ISS)
- Nominal End of Mission
- EVA Interfaces
- NBL Testing



# Kennedy Space Center Flow

- Arrive at Vertical Processing Facility (VPF) or Multi-Purpose Payload Facility (MPPF)
- Integrate AMS
- Top-off SFHe
- Power up/checkout Avionics and Charge Magnet
- Discharge Magnet and Power off all systems
- Package and transport to Space Station Processing Facility (SSPF)
- Integrated Verification Test in Launch Processing Integration Stand (LPIS) and PTCS
- Power up/checkout avionics, no Magnet Charge planned at this time



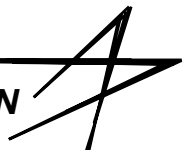
# Kennedy Space Center Flow (Cont.)

- Load into canister and transport to Canister Rotation Facility (CRF)
- Rotate canister in CRF
- Transport to Pad for Vertical Installation
- End to End Test in STS



# Prelaunch Operations Profile

- T<sub>0</sub> Umbilical requirements
  - Vent Pump, Cryocoolers, Cryo valves, CAB critical monitoring functions, and J-Crate
    - Power (120 Vdc)
      - Direct feed to Vent Pump
      - Through PDB for all other necessary avionics
    - 1553 for command/telemetry requirements
      - AMS provided GSE with network connection located in Room 10 of Mobile Launch Platform (MLP) to interface with AMS and AMS GSE in on-line facility at KSC
      - Serves as 1553 Bus Controller when OIU not enabled
    - Required continuously until T-9 min to monitor health status of Cryo systems (Vacuum Case pressure and SFHe pressure/temp)

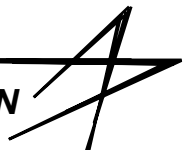


# Prelaunch Operations Profile (Cont.)

- $T_0$  Umbilical requirements (Continued)
  - Remainder of experiment avionics
    - High Rate Data via RS422
      - Can be used as command/data interface if problem with 1553
      - AMS provided GSE in Room 10 of MLP serving DDRS-2 functions
      - GSE interfaces with AMS and AMS GSE located in on-line facility at KSC via network connection
    - Required only for calibration and contingency troubleshooting operations

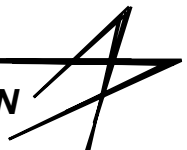
# Prelaunch Operations Timeline

- Installation through L-30 min nominal ops
  - L-88 hours complete Top-off SFHe activities
  - Approximately 650 W for J-Crate, Cryo valves, Cryo coolers, CAB critical functions, and SFHe Tank vent pump
  - Maximum of 2 kW for calibration and contingency should be completed prior to L-TBD days
- At L-30 minutes
  - Close SFHe Tank Vent Valve and deactivate Vent Pump
  - Deactivate Cryo coolers
  - Power down all equipment with the exception of J-Crate and necessary CAB functions to monitor of cryo system health (limited to 120W)
- Monitor health status of cryo systems till T-9 min;  
Go/No Go Call from AMS
- Launch, T0 disconnect (loss of 1553/power)



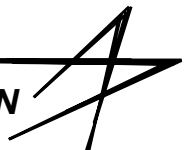
# Ascent Operations Requirements

- SFHe Tank Nominal Vent Valve operation
  - Barometric switch to open valve when PLB pressure is less than the SFHe
  - Time-tagged command via Backup Flight System (BFS) General Purpose Computer (GPC) to open as backup @ L+ TBD min
  - 28Vdc momentary power for valve opening and 5Vdc discrete for command
  - In the event of an abort barometric switch will close vent valve during descent
  - Any potential ignition sources will be compliant with NS2/81-M082



# Mission Abort

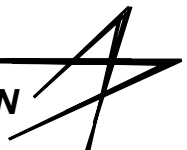
- In the event of an abort (e.g. RTLS, TAL, or any other return with AMS still in STS), power needs to be applied after landing to:
  - Allow internal Electronics to Monitor He tank pressure
  - Open Vent valve when He pressure exceeds 1 atm
  - Present calculations estimate the vent valve opening to be between 10 hours and 2 days, so power should be supplied approximately by Landing plus 5 hours
  - Not a safety concern, but rather a refurbishment concern (don't want to rupture burst disks)



# On-Orbit STS Operations Profile

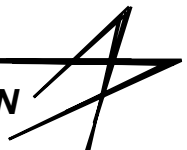
- Unstow and activate Digital Data Recorder System-02 (DDRS-02)
- Activate Assembly Power Converter Unit (APCU)s, Cryocoolers, and Housekeeping data at approximately Mission Elapsed Time (MET) 2 hr 30 min
- Activate/checkout AMS avionics subsystems and thermally condition payload
- Maximum power draw on shuttle 2 kW @ 120Vdc
- No magnet charging on STS
- Dock with ISS (MET Day 3)
- Transfer to ISS by MET day 4; Power down AMS just prior to transfer operations
- Grapple Flight Releasable Grapple Fixture (FRGF) with Shuttle Remote Manipulator System (SRMS)
- Disconnect Remotely Operated Electrical Umbilical (ROEU)
- AMS removed from PLB by SRMS

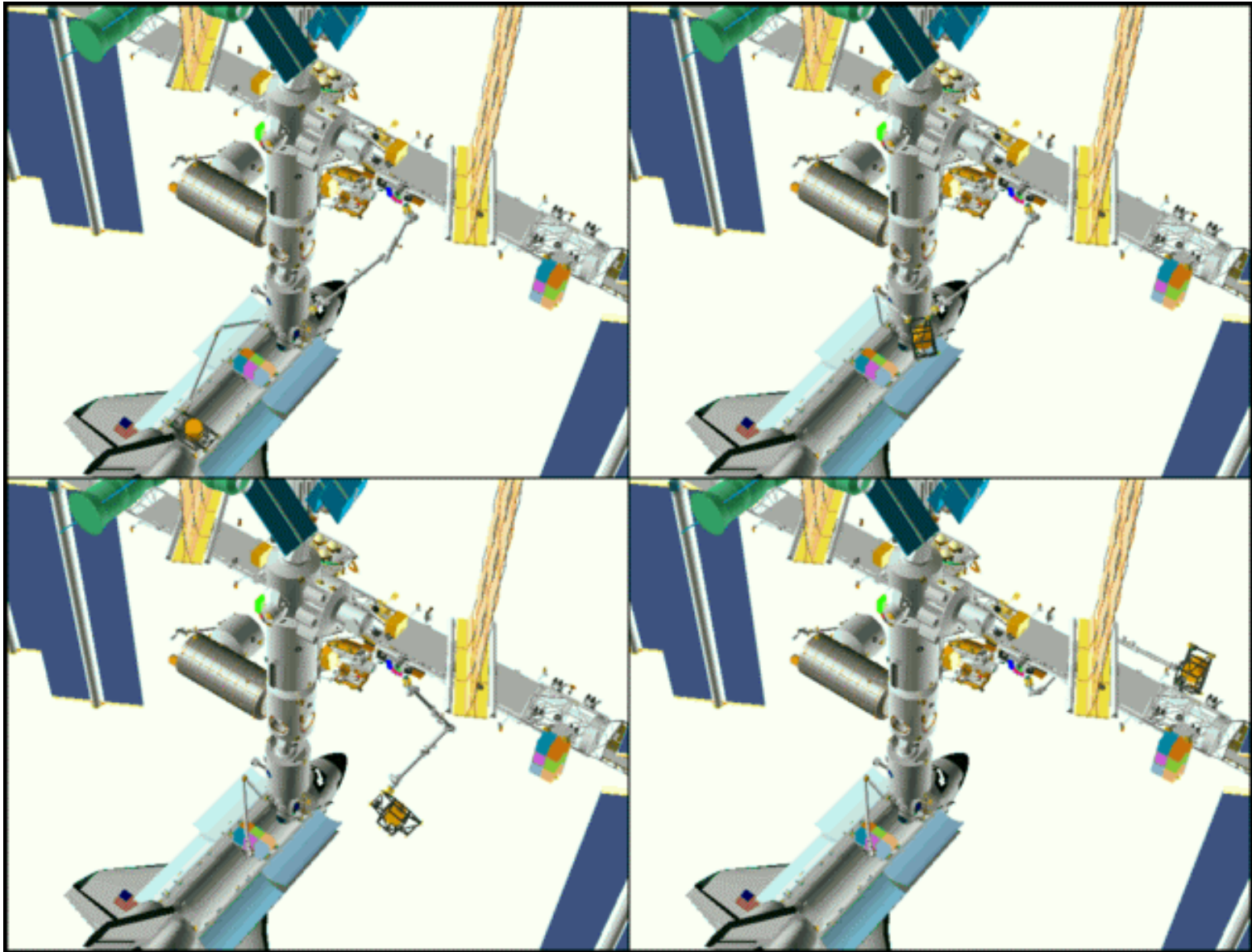
LOCKHEED MARTIN  
Space Operations



# On-Orbit ISS Operations Profile

- Grapple Power and Video Grapple Fixture (PVGF) with Space Station RMS
  - External Berthing Cues System (EBCS) utilized to verify final approach to Attach Site (Power and Video functions routed through SSRMS)
  - SSRMS supplies 1 kW power for AMS Heaters during Transfer Ops
- SRMS release of AMS
- Transfer to S3 attach site
- Attach AMS to S3 upper inboard site mechanical/electrical (via PAS & UMA)
- Deactivate power via PVGF and activate power via UMA





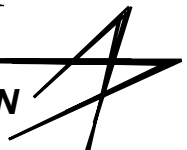
LOCKHEED MARTIN  
Space Operations



# On-Orbit ISS Operations Profile (Cont.)

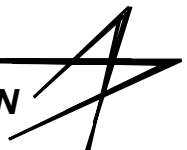
- Power up Avionics
- Perform abbreviated avionics checkout
- SSRMS Ungrapple
- Begin magnet charging operations (w/ crew monitoring)
- Once Magnet charging operation complete; begin 3 to 5 years of science data acquisition
- Stay/No Stay Call from AMS should be performed as late as possible prior to STS undock from ISS
- Primary control of AMS is from ground
- Crew interfaces to AMS via Express Rack Laptop through ACOP

LOCKHEED MARTIN  
Space Operations



# Nominal End of Mission

- For nominal End of Mission
  - The magnet will quench as the SFHe is depleted (nominal - assisted quench)
  - Avionics and heaters used to thermally condition experiment while awaiting return on STS
  - SSRMS to SRMS transfer
  - Stow in Shuttle Payload Bay using SRMS and Keel Camera
  - ROEU connection to power/data interfaces
  - Monitor avionics until Deorbit Prep
  - Barometric switch closes vent-valve on re-entry if not performed prior to removal from ISS
  - No specific ground processing requirements

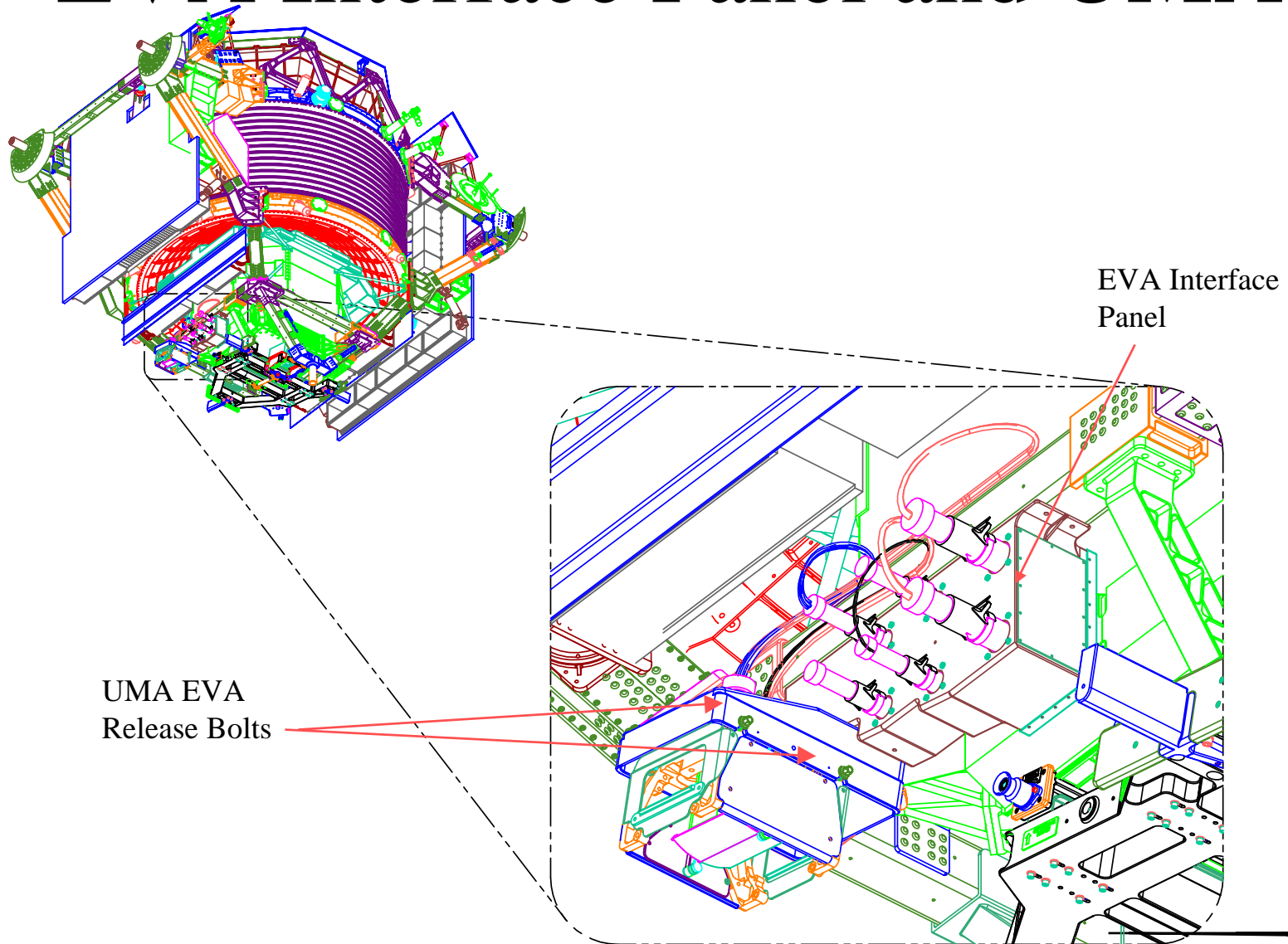


# EVA Interfaces

- Capture Bar Release and Passive UMA Removal contingency operations as required by SSP-57003
- PVGF Contingency Release
- Translation Paths on S3 Truss and Experiment
- EVA Interface Panel allows for redundant avionics interfaces in contingency scenario
  - Connectors will meet the mating/demating requirements identified in letter MA2-99-170

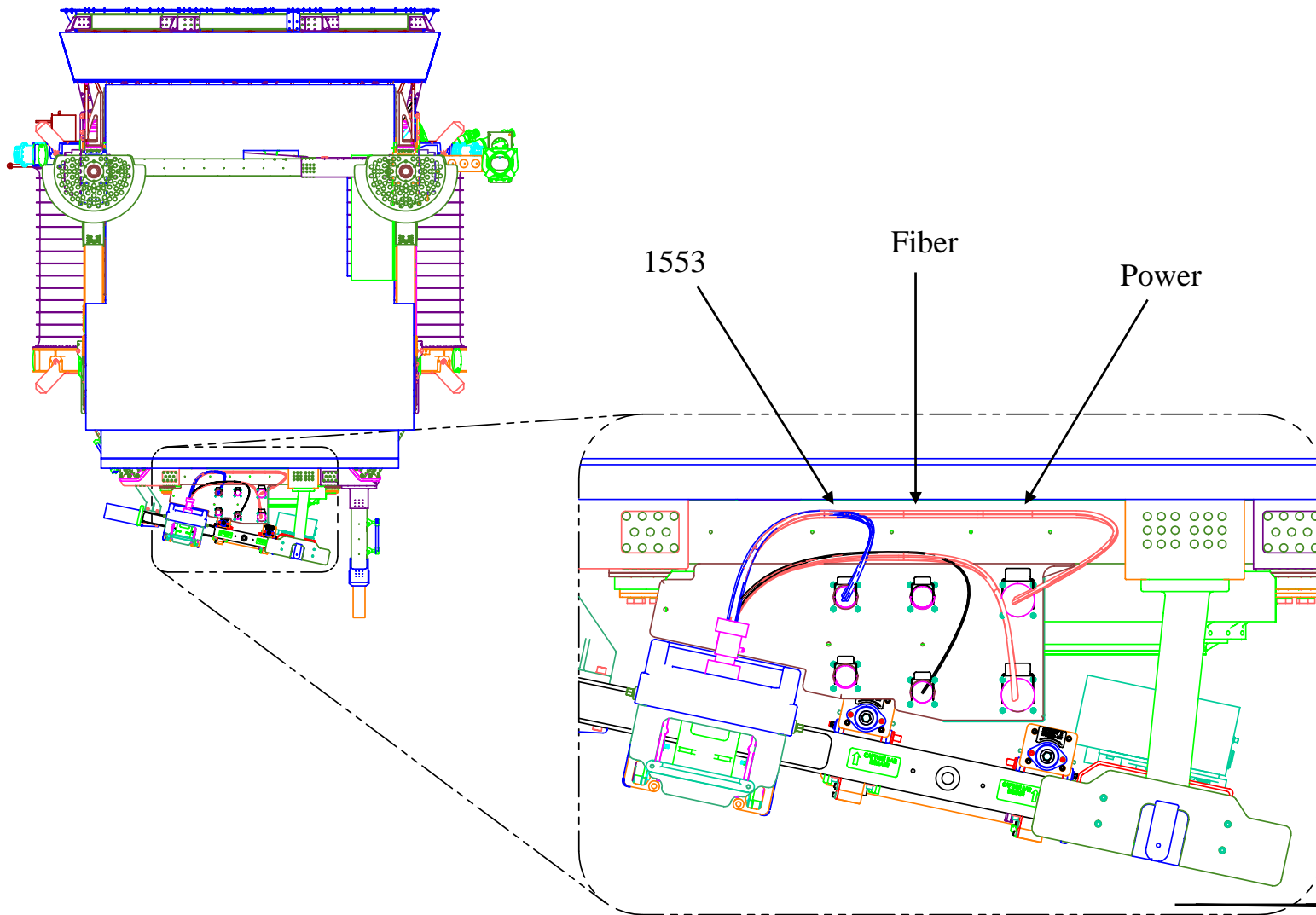


# EVA Interface Panel and UMA



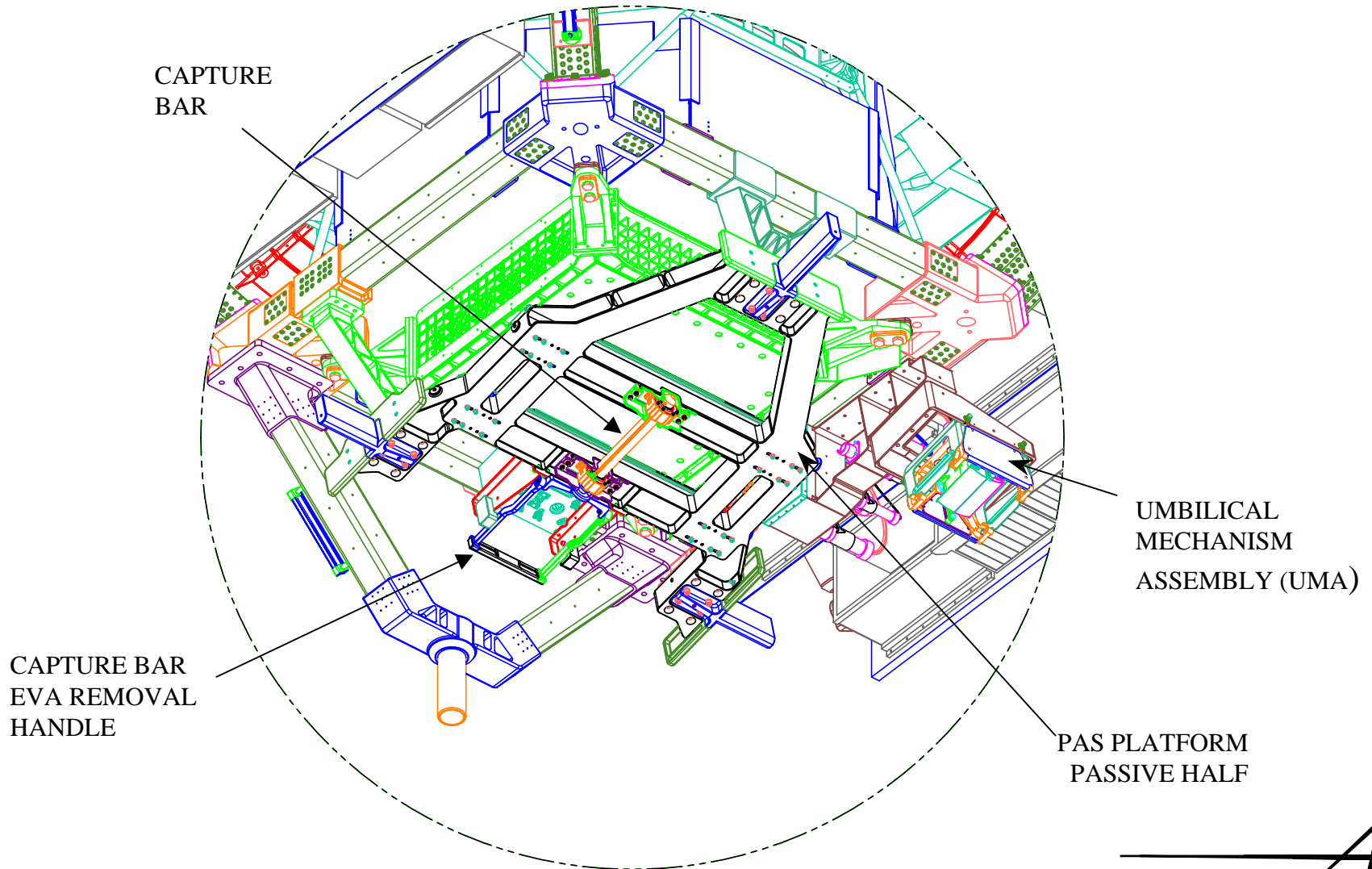
**LOCKHEED MARTIN**  
Space Operations

# EVA Interface Panel and UMA



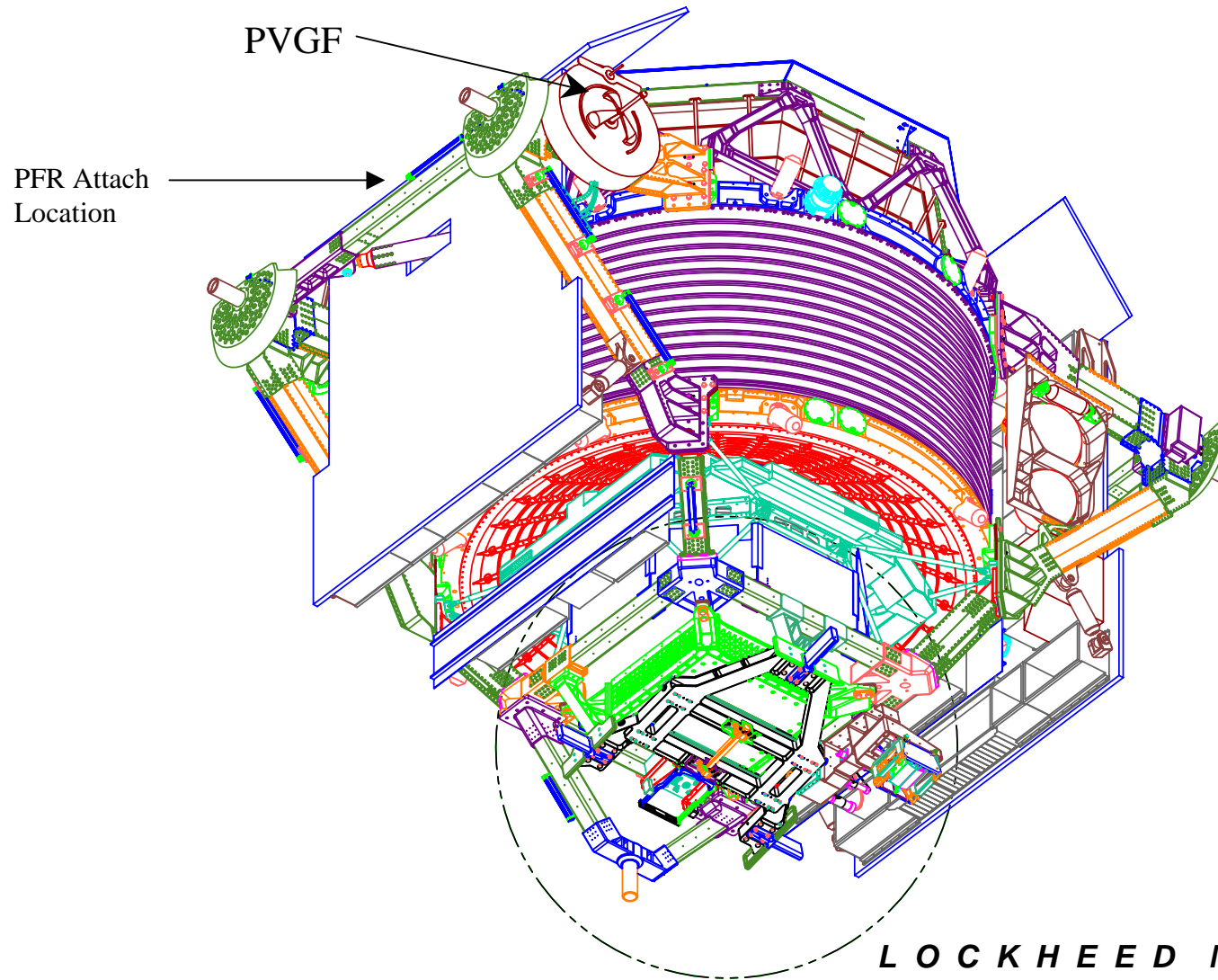
**LOCKHEED MARTIN**  
Space Operations

# Capture Bar



**LOCKHEED MARTIN**  
Space Operations

# PVGF Location



LOCKHEED MARTIN  
Space Operations

# NBL Testing

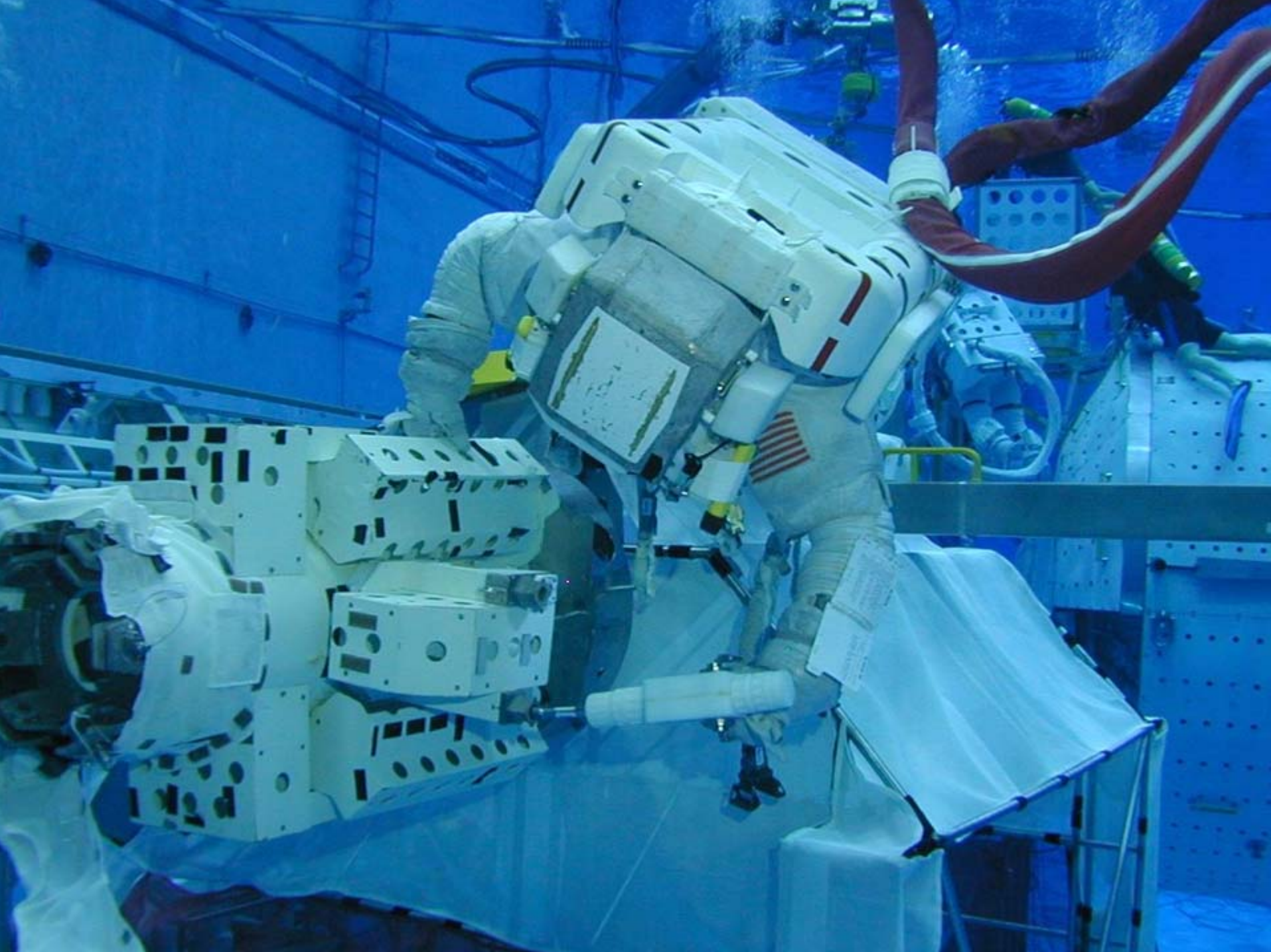
- First access test in NBL completed in March 2002 with low fidelity mockup (only Passive PAS)
- Second NBL access test (with higher fidelity mockup, full experiment envelope) performed in November 2002
- No mission specific NBL testing required
- No specific EVA training requirements



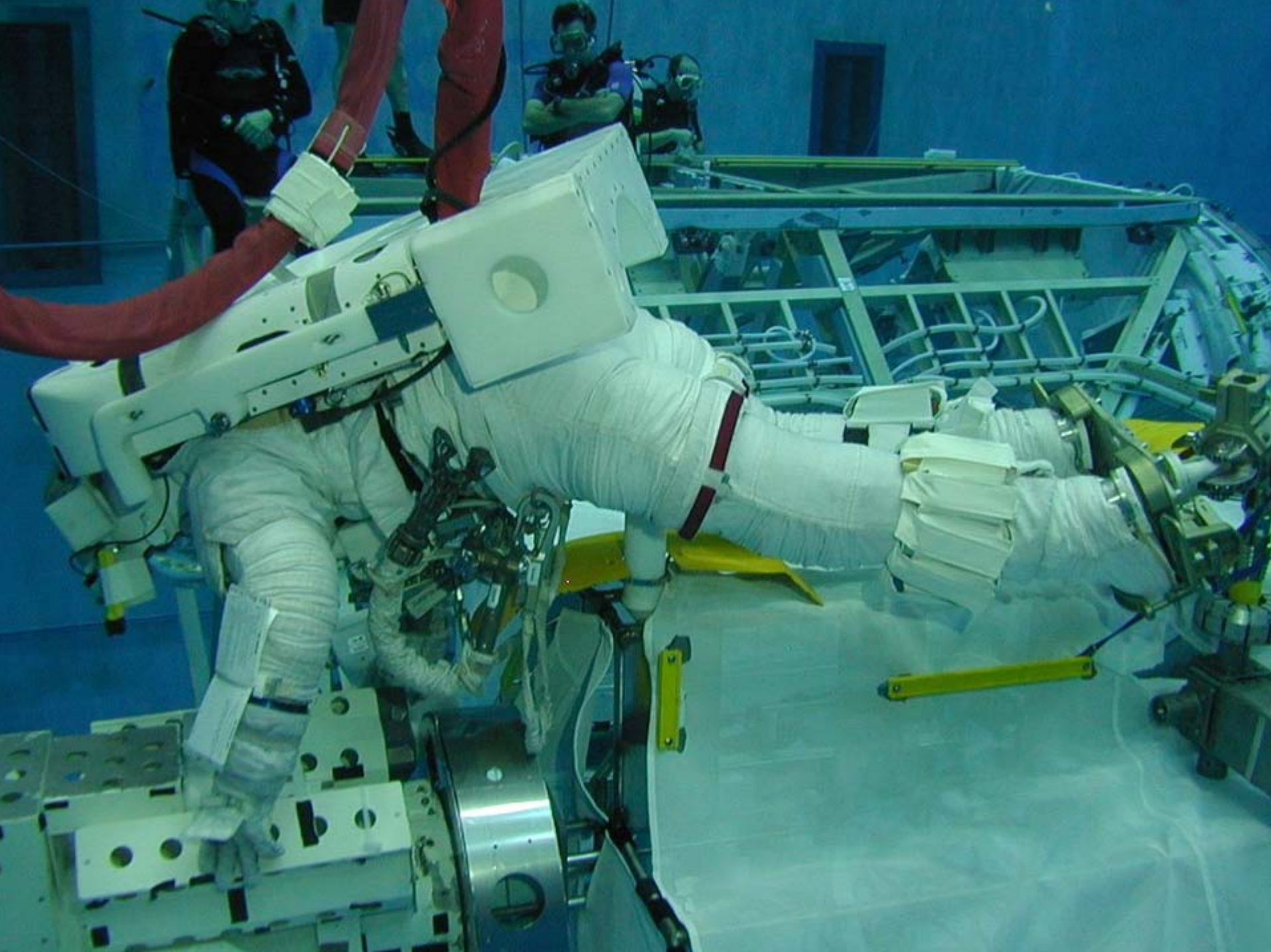
# November NBL Testing

- Testing to evaluate AMS Contingency EVA interfaces was performed November 12th thru 15th, 2002 (five crewmembers performed tasks)
- Testing included:
  - PVGF Contingency Release
    - PVGF Grapple Release
    - LEE Release
  - Capture Bar Unloading and Release
  - Connector Panel Access/Evaluation
  - Passive Umbilical Mating Assembly (UMA) bolt access
  - And, crew translation path evaluation















# NBL Test Results

- All tested tasks were deemed “acceptable” as documented in Crew Consensus Report (reference letter CB-02-129)
- Only minor issues identified with
  - Labeling (to be validated from drawings)
  - Fit-checks (verified with flight hardware at KSC IVT)
  - Connector clocking (verified by drawings)
- All issues resolved in the data-package
- Awaiting final review from EVA Project Office

